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'THE GENESIS FLOOD'
BOTANY

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(reviewed by David C. Watts and
N.M.de S. Cameron)

Editorial Committee

The Revd Nigel M. de S. Cameron, M.A., B.D.
Research student, New College, Edinburgh

J. Gordon McConville, M.A., B.D.
Librarian, Tyndale House, Cambridge

David C. Watts, B.Sc., Ph.D., M.Inst.P.
Lecturer in Materials Science, University of Manchester
Director of the Research Laboratories
of the Turner Dental School

EDITORIALS

Creation and Theology

The greatest difficulty with engaging in debate about creation is the fact that it takes us into a multiplicity of areas of learning. The exercise is essentially interdisciplinary, and the difficulty is that very few people feel equipped to move comfortably in more than one of the disciplines. Non-scientists, for example, will have dumbly admired the scientific expertise of one sort or another which went into the production of our Conference issue, Life on Earth. The scientific work, however, still leaves unanswered the question how to relate it to Biblical exegesis.

Biblical exegesis itself is rather a complex business. The Bible is, of course, the Word of God. And on one level it is true to say that the simplest believer can read it with understanding. However, it is equally true that the Bible was written down by ancient peoples, whose cultures were those of their time, and in languages long since dead. This means that understanding the Bible is only possible, humanly speaking, because a large amount of scholarship - historical, linguistic, literary - makes it available to us. Most Bible-readers are dependent on those who can turn the squiggles of Hebrew and Greek into readable English (French, Swahili, or whatever); equally, the Bible can be applied to modern living only when it has first been understood in its own cultural context.

This means that a certain amount of humility is called for in approaching the Biblical text. There is a danger of too readily assuming that issues of interpretation are clear, when in reality they are rather difficult. The form, meaning and literary genre of Genesis 1-11, perhaps more than any other part of the OT, are the subject of continuing debate among scholars. And it is clear that there are, for example, purely literary factors, as well as the historical, which have played their part in making Genesis 1-11 what it now is.

When such factors are taken into account it has surely to be admitted that some attempts to relate science and Scripture have been rather naive. Isaiah speaks of 'the circle of the earth' (40:22), and it is said that he knew the earth was round. In Job 38:7 we read: 'the morning stars sang together', and some wish to demonstrate scientifically that the stars emit radiations which might be described as singing. This sort of approach is misguided. The statements in question are poetical. To pin the truth of Scripture on arguments of this sort is bound to end in disillusionment.

How, then, do we tell what is a poetical expression of a truth in Scripture, and what is intended to relate sober, prosaic fact? It is clear, of course, that Genesis 1-11, just like the rest of Genesis, is in one sense profoundly historical. It could not be otherwise, in the essentially historical religion of the Hebrews (or, if you prefer, Judeo-Christian revelation). But that does not mean that it reads like modern historiography. There is a majesty and measured poise in Genesis 1 that puts it in a different category from the pedantry of twentieth century reportage. It is not hard to understand why some have wanted to see the description of creation as poetry. To describe it as such does not necessarily compromise its historical validity. We wish to affirm that Genesis 1 is fully historical. But just how it relates history is a different question. And upon this we are unwise to pronounce dogmatically until we can be confident that we have dealt adequately with the complex and technical questions of genre. If our apologetic is to be vigorous we must take seriously the enquiry into the character of the narrative, and what the experts have said about it.

One of the temptations which beset creationists is to try to answer essentially exegetical questions with scientific arguments. To say, for example, that the age of the earth is short (on scientific grounds), therefore Genesis 1 may be taken as a literal account, is a non sequitur, because it by-passes the exegetical task. The age of the earth may be short, for instance, and Genesis 1 poetic, with non-literal 'days'.

All this means that there is an exegetical and theological task to be done. We hope a start has already been made on this in BC; and of course it has also been going on in other places. Our brief is not just to 'hold our ground'. Rather it is incumbent on us, as upon all who are interested in the Christian revelation, constantly to challenge our own assumptions in the light of Scripture. About Genesis 1 we must ask, not merely, Is this to be taken literally?, but also, What does this aim to teach us in relation to the rest of Scripture? What is the relation of creation, theologically speaking, to redemption? (Much modern theology, with its tendency to centre on Christology, has also majored on redemption, to the neglect of creation.) And how does creation relate to eschatology? Evangelical belief in the ending of time by an act of God (in Christ's Second Coming) is not unrelated to our belief in its initiation by an act of God.

This is an ambitious and long-term programme. The present issue makes, we hope, a small contribution to it, though, as can be seen, we do not propose to slacken our efforts in the consideration of scientific and other related questions also. We hope you enjoy reading it.

J. Gordon McConville

Controversy and Correspondence

In an earlier issue we expressed the hope that readers would submit correspondence for publication in Biblical Creation. We should like to reiterate that invitation. Perhaps some points in Mr McConville's editorial will spark off discussion. In any event, correspondents should note that if their letters are to be considered for publication in the June BC they should be with us within a month of the publication of this issue.

Nigel M. de S. Cameron

CONTRIBUTORS AND ARTICLES

The Revd Dr D.A. Carson teaches New Testament at Trinity Evangelical Divinity School, Deerfield, Illinois, USA. We are grateful to him for sending us this article, and to the Northwest Journal of Theology (Canada) for permission to reprint it.

Dr Ieuan Davies is a botanist who works in plant breeding. His paper was first delivered at a Swanwick Creation and Origins Conference.

D. Alexander is researching in Old Testament at the Queen's University, Belfast.

NEWS

Biblical Creation

Readers will notice that our pagination re-starts with this issue, which we have called volume 2 number 5. There is no volume number on issues 1-4, and while the pagination of 1-3 is continuous number 4 is self-contained. We propose to give consecutive numbers to each issue produced, while adding a volume number and re-starting pagination for each calendar year. Thus fresh pagination and volume 3 will begin, God willing, in February 1981. We hope this system will be found convenient.

It has been found necessary, as a result of increases in both postal and printing charges, to raise the price of BC to 1.35, or 45p for a single issue (students 1.00 and 35p). At the same time an improvement in quality of typesetting is planned.

Life on Earth Day Conference

The Conference, papers from which were printed in BC4, was attended by between 400 and 500 people, a good proportion of whom were undecided about the issues discussed. It was not simply a gathering of the faithful! Answers on a questionnaire showed much appreciation of the addresses and a great deal of interest in the subject. Many of those present had travelled great distances to be present, and they included a minibus-ful of students from a Scottish university. Biblical Creation 4 has been selling extremely well - a run of 2,000 (twice the normal number) is almost sold out at the time of writing. Plans are in hand for a similar conference, provisionally arranged for November 8th, in the autumn of 1980. It is likely that the emphasis will shift slightly from scientific to other questions.

Many members will have heard the BBC Radio 4 report on the Conference, carried in their 'Sunday' religious news programme. Professor Andrews, who is President of BCS and was a speaker at the Conference, was interviewed, and in response there was an interview with the Rt Revd John Habgood, the Bishop of Durham.

Design in the Universe

A letter in Physics Bulletin 30(4), April 1979, on page 140, challenges the hope expressed by an earlier writer that 'we shall in the end come to a complete understanding of the formation and evolution of life'. Professor Henry Lipson, of the Department of Pure and Applied Physics, University of Manchester Institute of Science and Technology, writes as follows:

> 'Unwillingly, I am driven to the conclusion that living matter has been designed by a Designer who knows far more about physics and chemistry (and mathematics?) than we do. Most scientists find this concept anathema. Who designed the Designer?
> ... the idea that we can hope to understand the nature of life on the basis of our present knowledge of physics and chemistry I find completely untenable.'

The Challenge of

Genesis

Scientific Enterprise and the Word of God

a conference on

creation & origins

The next in the series of residential Conferences to be organised by Dr David Watts and Mr David Tyler at The Hayes, Swanwick, is to be from 27th-30th May. A leaflet giving full details was circulated with most copies of BC4. Further copies may be had from the Conference Secretary, 24 Harrow Rd, Brooklands, Sale, Cheshire. Mr Tyler and Dr Watts are both members of the Committee of the Biblical Creation Society, and they have proposed that future Conferences be organised by the Society. The Committee responded warmly to this request, and would commend this and future Conferences to the prayers and interest of members of the Society.

GENESIS QUESTIONS 2:

TOLEDOTH

D. Alexander

The meaning and purpose of the expression 'these are the generations of the heavens and the earth' in Genesis 2:4 has long been the subject of discussion among Biblical scholars - discussion which has often generated more heat than light. Two major problems must be resolved before an adequate understanding of this phrase can be obtained. First, what is the precise meaning of the Hebrew term toledoth which is generally translated 'generations'? Secondly, what relationship exists between Genesis 2:4 and the narratives which precede and follow it? Does it refer back to the account of Genesis 1:1 to 2:3, or is it an introduction to the narrative of 2:4ff.?

Before attempting to answer these questions two general observations should be borne in mind. First, the Hebrew word normally used for 'generation' is not toledoth but dor (which occurs over 100 times in the OT). Secondly, in the book of Genesis the expression 'these are the generations (toledoth) of' occurs ten times (2:4, 6:9, 10:1, 11:10, 11:27, 25:12, 25:19, 36:1, 36:9, 37:2), and the term toledoth is also found in Genesis 5:1 which commences 'this is the book of the generations of Adam'. The frequent occurrence of this formula requires that our understanding of its meaning and purpose in Genesis 2:4 be applicable to every other instance.

What then is the meaning of toledoth? The term itself comes from the root yalad meaning 'to bear', 'to generate' (which explains the English translation 'generation'). However, this alone is incapable of providing us with a clear definition of toledoth. Only by considering its actual use can one obtain clarity concerning its meaning. A survey of how scholars have understood the phrase 'these are the toledoth of X' reveals that it can be taken to mean either (a) 'this is the origin of X', or (b) 'this is what came forth from X'. Of these the latter is probably preferable since it can be applied more successfully to every occasion when toledoth is used in Genesis. Thus 'this is what came forth from X' can introduce either a genealogical list (cf. Genesis 5:1, 10:1, 11:10, 25:12) or a more detailed family history (cf. 11:27, 25:19, 37:2). We may therefore conclude that it is best to understand toledoth as standing for that which is produced, i.e., the result of bearing. Therefore it is possible to translate Genesis 2:4 by 'this is what came forth from heaven and earth when they were created'.

Finally, it is apparent that by adopting this view of Genesis 2:4 the verse provides an introductory title to what follows it, rather than a summary of what precedes it. However, as elsewhere in Genesis the phrase indicates a new point of departure in the narrative, in which it is assumed that the reader is already aware of how X came into being, so Genesis 2:4 also assumes that one is aware of the heavens and the earth from a previous account, which in this case is Genesis 1:1 to 2:3.

In conclusion, one final point ought to be noted as significant from a literary point of view. Every other occurrence of the toledoth formula in Genesis introduces material which we may term as 'historical narrative'. By inference it would appear that we ought to regard Genesis 2:3ff in the same manner. However, on the basis of one verse only, this must be a tentative conclusion.

"THE GENESIS FLOOD" IN PERSPECTIVE

D.A. Carson

In 1961, the Presbyterian and Reformed Publishing Company published a book that has stirred up not a little controversy. The Genesis Flood: The Biblical Record and Its Scientific Implications by John C. Whitcomb and Henry M. Morris was not just another half-baked attempt to prove the Bible was true by appealing to science, still less an effort to exonerate science by appealing to the Bible. Rather, beginning with the presupposition that the Bible is the Word of God and that its account of origins, understood in a coherent, literal fashion, is both true and scientifically defensible, it offered an innovative theoretical reconstruction of earth's early history.

Little time elapsed before the book was pilloried by its critics and praised by its defenders. Whitcomb and Morris were either heroic saints or villainous incompetents. For both Christians and non-Christians, it became a book to be discussed. Few who read it could remain thoughtfully neutral about it. It seems fair to say that most reviews, whether "academic" or "popular", waxed warm in either reproach or praise. Indeed, many reactions evinced more heat than light.

Perhaps it is worth taking another look at the effect the book has had. My concern in this article is not to recapitulate the materials in the work (I shall assume that those who read this article have already digested Whitcomb and Morris), but to ask why it became important, how it has been abused, what its weaknesses are. In addition, I shall suggest a few areas in which it could stand some updating, raise a few questions frequently put to me when the whole evolution question has been brought up, and provide a brief bibliography of some of the more significant works to have been written since 1961.

I should confess, at the outset, my own conclusions on this question. The cumulative evidence, both scientific and biblical, points, in my opinion, to a young earth. I would not want to see such a conclusion becoming a criterion of orthodoxy; nevertheless not only can this position be defended without committing intellectual hara-kiri, but I think it makes best use of the varied data.

WHY THE GENESIS FLOOD IS IMPORTANT

The book did not come to birth in a vacuum. When The Genesis Flood appeared, almost fifty years had elapsed since the "Monkey trial". But during those years well-trained creationists had not been entirely lacking, even if somewhat cowed.

For example, Dr Harry Rimmer wrote several works, his most influential one being The Theory of Evolution and the Facts of Science. More significant was the introduction to Everyman's reprint of Darwin's Origin of the Species. The introduction was written by Dr W.R. Thompson, a Canadian biologist, at the request of the publishers. Thompson, who openly disavowed all allegiance to Christianity, slated the rise of evolutionary theory as unscientific, and insisted that Darwinism had done inestimable damage to both scientific biology and to morals. Thompson was a lone voice crying in the wilderness. Not many heard him and even fewer paid any attention; but his credentials could not be impugned and, moreover, precisely because he was not a Christian, his motives could not be challenged.

Whitcomb and Morris, however, accomplished several things which none of their predecessors had achieved. First, they presented a fairly believable total package, and that at a fairly high level. What they attempted was a total synthesis of biblical data and hard scientific facts, to present a unified and coherent theory of origins and early pre-history, while arguing against other syntheses. For the first time in years, creationists were not poking away at isolated problems and scoring points in narrow areas of conflict. Former writers, by tackling relatively narrow questions, tended to reassure conservatives that answers for the broad problems were also available; but Whitcomb and Morris actually ventured a total perspective which, even if only approximately correct, entailed the conclusion that much modern science was entirely off the track. That they were taken up by so many so quickly points to the fact that many Christians were deeply sensitive to the lacuna in this area of Christian thought.

The second achievement of Whitcomb and Morris is related to the first. Just as they attempted a unified synthetic reconstruction of origins and early pre-history, so also did they venture to touch on a broad number of relevant disciplines. Evolution is an extremely complex theory and raises questions in scientific fields as diverse as palaeontology, biology, physics, geophysics, chemistry, statistics, mineralogy, meteorology; in biblical studies, areas as difficult as Hebrew semi-poetry, principles of hermeneutics, theology; plus epistemological and other philosophical questions; moral significance; and much more. No one can be an expert in everything; and, agree or disagree with Whitcomb and Morris as you will, it must be admitted that they cast their nets wide and became reasonably proficient in highly diverse specialties of human knowledge.

A third factor which commended the authors to many thoughtful Christians was that they quite openly began by considering the text of scripture, and only then moved on to scientific data. To the sceptic, of course, such a procedure was indefensible; but to the Christian who was fed up with articles and books which tried to make scripture conform to the latest theory - and that as often as not to authenticate scripture - there was a freshness, candour and reverence about their approach which merited respect and invited close scrutiny.

In the fourth place, Whitcomb and Morris wrote with a fairly irenical spirit, and with no trace of an obnoxious conservative obscurantism. There is no meaningless citation of endless proof-texts to "prove" that their particular interpretation is correct because "the Word of our God shall stand forever," or the like. They no doubt believe that God's Word shall stand forever; but they never stoop to plead this truth to defend their own understanding of the biblical materials. There is a certain integrity of argument which demands respect of the reader, not least when some particular argument fails to command assent.

Fifth, the authors of The Genesis Flood clearly see the immense implications for both biblical and scientific studies, should their presentation be correct, and calmly go ahead and argue their case. Their writing is therefore forceful, but not belligerent. This restraint, too often lacking among many (even) Christian writers, who like to give the impression that all who disagree with them are either retarded or ignorant, invested The Genesis Flood with a dignified sobriety which enhanced credibility.

HOW THE GENESIS FLOOD IS ABUSED

As in the case of any book that becomes something of a *cause célèbre*, The Genesis Flood has not escaped its share of searching criticism. My concern in this section, however, is not to survey these criticisms and assess them, but to clear the ground for further discussion by pointing to a few of the ways in which the book has been abused by both friends and foes. Of course, the form the abuse takes differs depending on whether it is the friendor foe who is producing it. The former do despite to the work by making it serve purposes for which it was not designed and the latter abuse it by levelling against it insubstantial criticisms calculated to evoke merely emotional reactions.

"Friends" of The Genesis Flood have sometimes welcomed the book with such obvious relief that they have lost all pretence of objectivity. They treat the work as if it were a knock-down-drag-'em-out argument that has successfully and forever put to flight every conceivable objection to biblical creationism. Any dissenting voice is dismissed as "liberal"; the book thus becomes a criterion of orthodoxy. Whitcomb and Morris themselves are more cautious. However strong the thrust of their main conclusions, the authors are the first to "emphasise ... that many minor details of (their) analysis of these problems may require modification in the light of further study" (p.xxiv). I would go further, and argue that the most important contribution made by the authors is the presentation of a coherent creationist alternative to both atheistic and theistic evolution. This contribution is abused when well-intentioned but poorly trained polemicists conjure up "improvements" and, worse, "deductions" which make any careful conservative writhe with embarrassment.

Opponents of the book have commonly begun by observing that neither Whitcomb nor Morris is a geologist, still less a palaeontologist. Morris can be written off as a mere "engineer", without noticing that his particular engineering credentials equip him to speak about the effects of flowing water (crucial to discussion about the deposition of sedimentary strata) with more authority than most of his critics. Moreover, charges of incompetence owing to a lack of formal training are, in themselves, both irrelevant and uncharitable. Similar charges could be levelled at figures as diverse as Jesus and Thomas Edison. Still less attractive is the condescending manner in which opposing arguments are frequently formulated. The only way to demonstrate an opponent's incompetence is to refute his arguments rationally, and so successfully that no plausible comeback is readily apparent. True scholarship thrives on open and fair debate. The preface to the sixth printing (1964) makes some pertinent observations in this regard.

Certain things that Whitcomb and Morris have discussed have, I think, been regularly misunderstood or misrepresented. Uniformitarianism is one; and, if I understand the arguments correctly, the second law of thermo-dynamics is another. On the first, critics would be well-advised to see the preface to the second printing; on the second, a little more later.

WAYS IN WHICH THE GENESIS FLOOD NEEDS UPDATING

Since 1961, when Whitcomb and Morris published their book, large quantities of ink have flowed as writers have probed earth's origins and early pre-history. As pivotal as The Genesis Flood has been, it could become even more influential if it were re-written to take into account three areas of this more recent literature.

First, a revised edition could answer many of the criticisms that have been levelled at the book. The most widely published critical review article has come from the pen of J.R. van de Fliert, Professor of Historial and Tectonical Geology at the Free University of Amsterdam. His article, "Fundamentalism and the Fundamentals of Geology," first appeared in The International Reformed Bulletin (Spring, 1968), and was subsequently reprinted in The Journal of the American Scientific Affiliation (September, 1969) and in Faith and Thought (Autumn, 1970). The tone of his article is somewhat caustic; but it has been adopted by many theistic evolutionists as the ultimate put-down of Whitcomb and Morris. Most of the article was simply a re-affirmation of uniformitarian "facts", stated with sufficient authority to cow the creationists and to reinforce the prejudices of the theistic evolutionists. Nevertheless, some of van de Fliert's criticisms deserve a more thoughtful response than he himself offered to Whitcomb and Morris. For example, he argues that the faulting and folding of areas such as the Heart Mountain Thrust of Wyoming and the Lewis Overthrust of Montana and Alberta constitute powerful evidence for the thrust-fault theory, used to explain why an apparently early rock stratum overlaps a later stratum. Whitcomb and Morris argued that the Lewis "overthrust" is of such colossal magnitude that small-scale faulting and folding provide no relevant parallels: the known friction coefficients of such heavy planes of rock dictate that transportation as a coherent block would be impossible. The lines are drawn; both sides present their claims as if they were unassailable. More recently, fresh papers have appeared on the subject; and I am persuaded that a revised edition of The Genesis Flood could provide the reader with a far more cogent presentation of the conservative case.

A more serious issue raised by the critics of The Genesis Flood brings up the second area in which the work could be profitably improved. This is the area of hermeneutics. A small digression may serve to clarify the problem.

Christian scientists have often accused Morris of being an incompetent scientist; but few have been able to say much against Whitcomb's competence as a biblical scholar, for the very reason that they know too little about the area. I am not trying to say that every evangelical biblical scholar agrees with Whitcomb; but the exegesis and interpretation of Genesis 1-11 which he offers is based on careful work and a transparent desire to treat the scriptures seriously. Scientists, who are Christians, and who disagree with the Whitcomb/Morris approach, are bound before God to outline what they think the first eleven chapters of Genesis really do say. It will not do merely to point out that there are others (e.g. B. Ramm) who take Genesis 1-11 less literally than does Whitcomb: the chief difficulty in discussing origins is the number of diverse disciplines involved; and the strength of The Genesis Flood is its synthesis of disciplines. Secular scientists may not have to bother with biblical evidence; but Christians will consider God's Word part of the given data, and in this area the only difference of opinion among them will be how to interpret that Word. If the opponents of The Genesis Flood want to make a dent in the following that Whitcomb and Morris enjoy among thoughtful evangelicals, they will have to produce a work or works equally given to coming to terms with what the Bible actually says, as well as to scientific arguments defending their particular interpretation of the hard facts. This point is made, somewhat polemically, by J.C. Whitcomb himself, in his later and less technical book, The World That Perished (1973).

That brings us to the heart of this second issue, viz. hermeneutics. Not a few writers have argued that Genesis 1-11 cannot be taken literally, usually by appeal to Hebrew "semi-poetry". See, for example, R. Youngblood's article, "Moses and the King of Siam," JETS 16(1973), 215-222. An overlooked article in defense of a more conservative hermeneutic is "The Hermeneutical Problem of Genesis 1-11", written by N. Weekes in the Theological Review, a mimeographed paper produced by the Australian Theological Students' Fellowship, Vol. 8, October 1972. To recapitulate their arguments would treble the length of this article, and in any case miss the point I want to make: The Genesis Flood could be significantly improved if it were revised so as to incorporate intelligent interaction with the hermeneutical pundits, especially those who have written since 1961.

Thirdly, and most important of all, The Genesis Flood could be updated and improved by incorporating some of the best work produced since its initial appearance. Such work is part of a continuing movement of which The Genesis Flood itself was the chief catalyst. The time is ripe to summarise it and criticise it, preserving the best and rejecting the worst, providing new impetus and direction for research in coming years. I shall arbitrarily select a few areas that could enrich a revised edition:

(1) Several "origin of life" experiments, such as those by H.C. Urey and S.L. Miller, have received considerable attention in the standard scientific journals. They have also been vigorously criticised, especially by Duane T. Gish in Speculations and Experiments Related to Theories on the Origin of Life: A Critique (1972).

(2) When The Genesis Flood was published, geology had little patience with theories of plate tectonics. Now, for better or for worse, plate tectonics is so much "in" as to have become the new geological orthodoxy. I do not think that as a result any new hard facts have come to light of such a nature as to jeopardise the Whitcomb/Morris approach. However, their book is badly dated in that geology no longer uses precisely the same categories which it did when they put pen to paper.

(3) We continue to read published reports of humanoid bone structures, such as those found in the Olduvai Gorge, variously dated at two million plus years. Ironically, Carbon 14 dating methods put the same structures at a tiny fraction of that age (between 10,000 and 20,000 years). But in any case radioactive dating procedures have churned out more results that need to be analysed, and one or two novel methods.

(4) There are new discoveries which need to receive an airing outside merely technical books and journals. For example, in astronomy a few voices have been raised to question the correlation between large red-shift and great (and increasing) distance. If this correlation is ever broken down, modern cosmology is called into question. More striking yet are recent observations on the earth's magnetic field. It has been pointed out that there have been worldwide magnetic field measurements going back to the work of Gauss in the 1830s; and on the basis of 130 years of observation, it appears that the rate of decay of the earth's dipole moment is approximately five per cent per century. The data confirm the theory of exponential decay. If sound, this specifies a half-life of about 1400 years. If we take, as a limiting value for earth's magnetic field, something less than that of a magnetic star, the upper limit of the age of the earth's magnetic field (assuming a constant rate of decay) is less than 10,000 years. How cogent apiece of evidence is this for a young earth?

(5) Thus, precisely because The Genesis Flood has been so seminal it would be very helpful to have a second edition which would thoughtfully survey the spate of more recent literature, incorporate the most cogent material, and introduce the reader to the best of the multiplying bibliography. Although I readily confess I am not expert in the area of origins - I could easily be accused of being a seed-picker, and with more justification than when the charge was levelled against Paul (Acts 17:18) - I shall, a little further on, mention some of the more significant literature to appear since the publication of The Genesis Flood.

SOME QUESTIONS FREQUENTLY RAISED

During the past ten years I have, somewhat reluctantly, occasionally lectured on the subject of evolution and the Christian faith. From the discussions which invariably ensue, I have undoubtedly learned far more than my patient listeners and questioners. One thing I have learned is that certain questions crop up time and time again. Of these, I shall select four on which to offer a few brief reflections.

(1) It is often said that natural selection has been demonstrated in practice by the rise of certain strains of DDT-resistant flies, or the predominance of dark moths over light ones in industrialised areas of

Great Britain, where the darker colour provides added protection from predators. This is not the place for detailed rebuttal; interested readers will get more help from *inter alios*, B. Davidheiser, *Evolution and the Christian Faith* (1969), pp. 189ff.; and J.W. Klotz, *Genes, Genesis and Evolution* (second edition, 1970), 219ff. Suffice it to point out that the complexities surrounding natural selection are enormous, and regularly underestimated. For example, a favourable characteristic for the adult individual may not have the opportunity to develop unless it is equally favourable when the individual is young, a period during which, in many cases, a high mortality rate exists. Moreover, where there is intensive selection, there are fewer varieties. For example, the cichlids are found in all the great lakes of Africa. Where predators occur, as in Lake Albert, only four species are present; but where there are no predators, over fifty species are found. Thus, intensive selection might slow down and even defeat evolution, for the organism will have less flexibility to exploit a change of habitat. Indeed, intensive selection may force the extinction of the organism because the organism has become so highly adapted to its special environment it cannot survive any change. Flexibility appears to be more important than special fitness; and if so, models for natural selection must walk a statistically improbable tightrope between flexibility and environmental incentive to change. Another problem is that the positive value of small differences, though frequently alleged, has in many cases not been demonstrated. Yet again, and most significantly, the palaeontological records do not show the smooth transitions required by the theory.

Much more could be said; but I shall focus attention briefly on the moths and flies just mentioned. The hard numerical data can sustain interpretations other than that natural selection is at work. More melanic moths may survive because their lighter cousins have been killed off; and those flies most susceptible to DDT are the ones likely to get killed off. The question at this point is whether natural selection is primarily responsible, and whether resulting matings produce an unambiguous shift in population characteristics. Here recent results are both more complicated and more ambiguous. It has been suggested that in the case of DDT-resistant flies, mechanisms other than natural selection may be at work: DDT may have itself stimulated the production of hormones or enzymes which protect against DDT (an enzyme which removes hydrochloric acid from DDT has been shown in the resistant flies); there may be other factors carried in the cytoplasm. Some experiments with mated melanic moths have produced a higher proportion of melanics, but others have not: again the problem seems to be far more complex than was first realised. Suppose, however, that we are dealing with a single mutant gene: there is still an infinite distance between this mutant and the kind of natural selection that would be required to change a moth into something not-a-moth.

In the light of this sort of evidence, it is surely a doubtful method which makes so much turn on the mechanism of natural selection. For example, Julian Huxley, in his book *Evolution in Action* (1953), 45f., offers a figure to illustrate the *probability of a horse* being produced by evolution, through mutations alone, without any natural selection. There is, he says, one chance out of a number so large as to require three volumes of five hundred pages each just to print it - when, as Davidheiser points out (p. 203), "it would take less than two lines in a book to record a number larger than the estimated number of electrons in the known universe." Huxley considers this to be tremendous evidence for the importance of the role of natural selection: horses exist, mutation cannot account for them, and so natural selection must be invoked. I think the Christian can provide a more believable alternative.

(2) But what about the horse? Perhaps the palaeontological evidence does not reveal as smooth a development as evolutionists might wish; perhaps the mechanism of natural selection has indeed been overrated; but surely the fossil evidence of the horse proves that evolution took place, at least in this one case? And if in this case, why not in others?

The alleged evolution of equus from eohippus is regularly taught as irrefutable. The counter arguments are complex, but quite persuasive. Because they are both lengthy and involved, I merely refer to what is, to my knowledge, the best article on the subject. F.W. Cousins, "The Alleged Evolution of the Horse," A Symposium on Creation III. ed. D.W. Patten (Grand Rapids: Baker, 1971), 69-85.

(3) A third area of perennial concern is the second law of thermodynamics. Some treat this law as if it were the final refutation of all evolutionary schemes. Others suggest it may not operate at the scale of the universe. Some argue that although it is a well-tested law of physics, it is inapplicable in the area of biology.

The following observations may be helpful. First, no studied physical process has been shown to set aside the first and second laws of classical thermodynamics. Albert Einstein has been quoted as saying:

> Classical thermodynamics ... is the only physical theory of universal content concerning which I am convinced that, within the framework of applicability of its basic concepts, it will never be overthrown (M.J. Klein, "Thermodynamics in Einstein's Thought," Science 157 (1967), 509).

This means that modern theories which outline a cyclical pattern in the universe (e.g. endless expansion/compression cycles), although not disproved, are no more than the merest speculation.

Second, a philosophically materialistic theory of evolution eschews, by definition, all vitalism. Therefore all biological processes are nothing more than matter/energy processes which are subject to the known laws of thermodynamics.

Third, mechanistic biologists will usually concede this point, or even insist on it if it means the overthrow of vitalism. But they then argue that within a finite system it is possible to negate the entropy principle, especially if energy is being added from an external source. To such a biologist, the growth of a plant from a seed, the development of an adult from an embryo, and the evolutionary development of new species up the phylogenetic scale, are all examples of such finites, local negations of the entropy principle. But I would argue that the last example, evolutionary development, is qualitatively different from the other two. In the case of growth from an embryo to an adult, or from a seed to a tree, there is no spontaneous increase in order because all the ordering information is encoded in the genetic system of the embryo or seed. Evolutionary development is utterly different; and indeed it has been shown repeatedly that the first initiation of any process of self-replication must be rejected as so statistically and thermodynamically improbable that only the most committed materialist could believe it.

(4) I raise one more question, one that has appeared more and more regularly of late. It is epistemological: What evidence would I permit to stand against all this creationist theorising? The verification principle of Ayer has been accorded a decent burial; but this falsification principle has been put to me quite forcefully. The first time I faced it, in Cambridge, England, I was unprepared for it and answered rather lamely. Upon further reflection, I think I would say three things.

First, whereas creationists need to face the falsification principle squarely, committed evolutionists need to face it even more. How much evidence, and what kind of evidence, would force the evolutionist to abandon the theory of evolution?

Second, the falsification principle is usually restricted to testing single propositions. It is more difficult to handle when applied to complex theories with many propositions, only some of which are essential to the theory, while others are negotiable. One ought to be able to apply the falsification principle to most, if not all, of the essential propositions which make up the theory; and in that case any one of these falsification tests would serve as a test of the entire theory. The only way to escape, should any essential proposition prove false, would be so to modify the theory that the false proposition would no longer be essential to it.

That brings me to the third reflection. If there were one piece of hard evidence that would make me abandon the creationist position, I think it would be the discovery of stratified fossils which show the smooth gradation required by the evolutionary model. There could be many others; but that, to me, would be a thoroughly reliable falsification test. And, I venture to say, it is the ability of Whitcomb and Morris to cope with the available data from sedimentary deposits that make The Genesis Flood as influential as it is.

What falsification test(s) will my evolutionist colleagues now be prepared to accept?

A SELECT ANNOTATED BIBLIOGRAPHY OF BOOKS WRITTEN SINCE THE GENESIS FLOOD

The number of books and papers being written in the area of evolution and Christianity is increasing exponentially, and I almost hesitate to make a selection. I shall limit myself to those I have found most helpful; and, for convenience, when a book has been published in several countries by different publishers, I shall refer to the company that produced the one I happen to possess.

Most of the following authors are Christians, but not all of them. Those who are do not always agree with one another; but that should cause no one any concern as neither do the evolutionists. One of the most important lessons to learn is how little is really universally agreed in the science/religion interface.

I begin with two stimulating books written by non-Christians. The first appeared just before The Genesis Flood, but came into prominence only after it. It is called Implications of Evolution. Written by G.A. Kerkut and published by Pergamon Press in 1960, it raises biological problems of evolutionary theory from within the framework of commitment to that theory as a working hypothesis. Less technical but more trenchant is N. Macbeth's Darwin Retried: An Appeal to Reason (Gambit, 1971). Macbeth, a retired lawyer, has read extensively, and still accepts evolution in the large sense; but he is a deadly foe of illogical arguments, inconsistency, unfounded assumptions, invalid conclusions, and the like. Since these things constitute an embarrassingly high proportion of evolutionary theory, Macbeth becomes an impressive protagonist.

An important book for Christians is F. Schaeffer's Genesis in Space and Time (Hodder, 1972). Theistic evolutionists often tell us that Genesis 1-11 cannot be taken literally; but rarely do they tell us just what these chapters actually do mean. Schaeffer unfolds the minimum theological content, the least that God is saying in this part of his Word, if the Bible as a whole is to make sense. He does not solve all the problems, and on some points I think he gives a needless amount away; but his book is a good place to start, and, implicitly, a limiting factor to careless generalisations.

There are several general works on science and Christianity which are helpful. Showing us where present trends are leading us are Denis Alexander, Beyond Science (Lion, 1972), and some chapters of Os Guinness, The Dust of Death (IVP, 1973). Two standard works are those by M.A. Jeeves, The Scientific Enterprise and the Christian Faith (IVP Tyndale Press, 1969), and Bernard Ramm, The Christian View of Science and Scripture (Paternoster, 1964). Both of these men take a theistic evolutionist line, and Ramm holds to a limited flood; but they are important nonetheless and deserve a careful reading. More concerned with the question of evolution per se is a symposium edited by Russell Mixter, Evolution and Christian Thought Today (Eerdmans, 1960). Again, however, I would say that most of the essays in this volume give too much evidence to the transient claims of science. Another symposium of some work is Rock Strata and the Bible Record, ed. P. Zimmerman (Concordia, 1970). The contributors are far from agreeing; but the discussion is competent. There are some fascinating pictures of how several so-called "hominid" skulls could be fleshed out to make a perfectly believable modern man.

After the publication of The Genesis Flood, J.C. Whitcomb authored two slimmer volumes more suited to the reader untrained in the sciences. They are The World that Perished, (Baker, 1973) and The Early Earth (Baker, 1972). Both deserve wide circulation. Equally popular is H. Enoch's Evolution or Creation (Puritan, 1967).

Two of the most impressive books have come from the pen of A.E. Wilder Smith, who has three earned doctorates and is head of Pharmacology at the Medical Center in Illinois. Despite his professional competence, his books are readable: *Man's Origin, Man's Destiny* (Shaw, 1968), and *The Origin of Life: A Cybernetic Approach to Evolution* (Shaw, 1970). Neither volume has received the attention it deserves. Well worth buying, also, is Bolton Davidheiser's *Evolution and the Christian Faith* (Presbyterian & Reformed, 1969). Davidheiser earned a Ph.D. in genetics before becoming a Christian. The transformation prompted him to re-think his entire world-view, especially the relationship of Christianity to his own discipline. This book is the result. It is a trifle polemical in tone and not very well organised; but it boasts masses of detailed documented information. Evan Shute, *Flaws in the Theory of Evolution* (Presbyterian & Reformed, 1961), likewise picks up many points of detail. His discussion of cranial capacities is most helpful. Unsurpassed in its field is the book by J.W. Klotz, *Genes, Genesis and Evolution* (Concordia, 1970).

From the point of view of anthropology, R. Laird Harris, *Man - God's Eternal Creation* (Moody, 1971) is a helpful place to begin. Two important books in the area of the history and philosophy of modern science have been written by G.W. Clark, *The Philosophy of Science and Belief in God* (Craid, 1972), and R. Hookyaas, *Religion and the Rise of Modern Science* (Scottish Academic Press, 1972); but they should be read against the background of some such critical work as *Issues in Science and Religion*, ed. I.G. Barbour (SCM, 1966).

Creationists with an M.Sc. or more, in one of the physical sciences, may join the *Creation Research Society* (CRS), a break-away from *The American Scientific Affiliation* (ASA). The CRS publishes a quarterly, and from time to time reprints important articles in symposia fashion. These are of mixed value; but some very substantial work has appeared in this form. At least four volumes have appeared (Baker). The CRS has also produced its own junior high school text-book of biology. Edited by J. Moore and H.S. Slusher, it is called *Biology: A Search for Order in Complexity* (Zondervan, 1970), and deserves to be read by all high school students who are studying the biological sciences. The ASA, by contrast to the CRS, typically supports theistic evolution in its journal (JASA).

The CRS is restricted in its membership to the technically competent. However, there is another group which caters to the scientifically untrained. It is called the Bible-Science Association, and prints a monthly paper (8 pages of newsprint) called the "Bible-Science Newsletter", containing some low-level science articles, news, of the creationist movement, and some helpful bibliographical details. The address is Box 1016, Caldwell, Idaho 83605, USA. My chief hesitancy in mentioning them is their lack of discrimination. They have occasionally backed wildly speculative work, or ultra-conservative books.

On Genesis 1 itself, the best buy, in my judgement, is still E.J. Young's *Genesis One* (Presbyterian & Reformed, 1964). However, this is a technical piece for students who have kept up their Hebrew. Almost as good, and much less technical, is F.A. Filby's *Creation Revealed* (Revell, 1963).

My knowledge of literature in this whole area is far from exhaustive; but the above works are among those I have found most helpful. Above all, I never tire of opening the Scripture and reading afresh the account of origins and pre-history left us by the Holy Spirit himself.

CREATION AND BOTANY

Ieuan Davies

The subject is approached from the stand point of the crop botanist. This is appropriate for two quite distinct reasons. First, the work of the crop botanist may be regarded as one aspect of the command to Adam in Genesis 1:28-9 to subdue the earth. Second, during the century there has been a very close connection between evolutionary studies and horticulture and agriculture; this is because some of the most influential geneticists (C.D. Darlington, K. Mather) worked on horticultural and agricultural species, and R.A. Fisher, evolutionary geneticist and statistician, was responsible for some of the most significant advances in the methodology of agricultural and biological experimentation.

This paper has three objectives:

1. to illustrate, by reference to Fisher's work, some characteristic features of biological science.
2. to note some recent comments on evolutionary theory in relation to 1.
3. to clarify the relationship between some aspects of the biblical record in Genesis 1-3 and contemporary studies of crop plants. Genetic and taxonomic studies are considered in relation to "after his kind" (Gen. 1) and current views of crop and weed species are examined in relation to Gen. 1:12 "... and God saw that it (the plant kingdom) was good," and Gen. 3:18 "... thorns also and thistles..."

1. R.A. Fisher and biological experimentation: some illustrations

Let us suppose that we wish to determine which is the higher-yielding of two varieties of barley. We sow plots of the two varieties in each of 10 fields in various parts of Britain. In seven of the locations we find, at harvest time, that variety A gives a better yield than variety B; in one instance B gives a slightly higher yield than A; and in the remaining cases there is virtually no difference. On average variety A is clearly the higher-yielding. In general, according to Fisher's theory, this sort of situation arises because the relative yield of the barley varieties is influenced by a large number of factors. Our ten fields will no doubt differ with respect to: the clay mineral composition of the soil, drainage, spring temperature, aspect, rainfall, and many other factors. These factors interact the one upon the other; the clay composition affects the drainage, and this in turn affects the spring temperature; the rainfall, temperature and aspect affect the incidence of plant diseases. To each of these factors (and others of which we know little or nothing) our two barley varieties respond slightly differently and their overall performance is the summation of their reactions to this complex of interacting factors.

One of Fisher's greatest contributions was to devise a method of analysing such results; his work greatly enhanced the objectivity of biological experimentation. However, returning to our illustration, an experienced agricultural adviser who recommended variety A to all farmers would not be unduly surprised if one or two farmers reported that variety B was at least as good as variety A. In fact Fisher's analysis could be used to estimate the proportion of such anomalies. The point we wish to make is that when, on the basis of a properly conducted scientific experiment, we say that variety A is higher yielding than B we are making a generalisation which is very useful, but which cannot be regarded as being in any sense an absolute truth.

A further point may be made: the theory underlying Fisher's statistical analysis has been challenged in the past couple of decades by a school of statisticians who have sought to develop theories propounded by Rev. Thomas Bayes two centuries ago. Also, Fisher's genetical theories have been challenged by the animal geneticist Waddington. Waddington contended that Fisher's theories take account only of the genotype, i.e. ignoring the phenotype, also that they assumed only one, uniform environment. These challenges illustrate a point made by J.A. Nelder, D.Sc., in a book directed at sixth form readers. Theories, he contends, can never be verified; they may, however, be falsified, i.e. when experimental results are obtained which do not support them (Nelder, 1975).

2. Views of some contemporary evolutionists.

With this background in mind it is worth noting views expressed in recent evolutionist writings:

(a) R.H. Peters (The American Naturalist, February, 1976)

> "The testing of evolutionary theory against observation, is, at best, extremely difficult (Slobodkin, 1968), and Scriven (1959) suggests that it is not to be expected. Birch and Ehrlich (1967) maintain that our theory of evolution is 'not necessarily false' but 'outside of empirical science'."

(b) Prof. Ronald Good (Features of evolution in the flowering plants, 1956)

> "There are still deep divergences of opinion about the nature of evolutionary processes, while it is the experience of many that increased acquaintance with the literature brings more rather than less uncertainty."

(c) Prof. C.W. Wardlaw (Organisation and Evolution in Plants, 1965)

> "Gaps in the fossil record are unavoidable; the plant remains have simply disappeared, or have not yet been found. But there are other gaps in genealogical constructions which may not be due to the incompleteness of the fossil record. Such gaps should be capable of being explained, or perhaps ' explained away...'"

It cannot be said that these are representative of works on evolution, but at least they indicate that some evolutionists are less than completely convinced by their own arguments.

3. Modern genetics and taxonomy in relation to the Genesis 'kinds' and the 'thorns and thistles'.

In this section we consider: (i) variability in plants, the viewpoint of the population geneticist, (ii) races, species, genera, and hybrids between them, (iii) crop plants and weeds.

(i) VARIABILITY IN PLANTS

To illustrate the approach of the population geneticist we shall consider how a short-lived species, the herbage grass cocksfoot, reacts to contrasting weather conditions.

At Sintra, near Lisbon, there is a type of cocksfoot which makes unusually good growth in autumn. Winters at Sintra are almost invariably mild, and the prolific growth during autumn/early winter enables the plants to lay-by sufficient reserves to tide them over the often scorching conditions of the following summer period. When plants of the Sintra cocksfoot are grown in hill regions of Wales only a handful survive the relatively harsh winter conditions; it is clear that amongst cocksfoot plants from Sintra there is considerable variation with regard to their capacity to survive such winters, those making the most abundant autumn growth being most susceptible. The population geneticists' explanation of this variability would be somewhat as follows: Severe winters are not unknown at Sintra, and on such occasions a large proportion of plants, mostly those making luxuriant autumn growth, die. However, after a further 5-6 winters of the usual mild type, one would expect to find that the proportion of plants capable of good autumn growth, (but susceptible to the severest winder conditions) is restored. This is attributed to a delicately balanced genetic system as a result of which most of the seeds shed give rise on germination, to winter-susceptible plants, but there is always a certain proportion of seeds which give rise to winter-resistant types. There is also considerable variability in the viability of the seed, hence there will always be a small proportion of seed and seedlings of the winter-hardy types; these are favoured temporarily when a severe winter takes its toll of the more susceptible plants. The genetic make-up of the winter-hardy types is such that their progeny will include winter-susceptible plants. The genetic mechanisms involved are briefly described by Thoday (1959). The population geneticist is concerned not so much with the characteristics of the individual plant as with those of communities of individuals. Prof. Thoday tells us that such communities "have evolved mechanisms that permit them to carry potential variation without showing corresponding actual variation".

(ii) RACES, SPECIES, GENERA; HYBRIDISATION

Some definitions of species.

(a) The 17th century philosopher John Locke:
"the boundaries of species, whereby men sort them, are made by man".

(b) Linnaeus (1738):
"there are as many species as there were originally created diverse forms".

(c) Linnaeus (1774):

"Let us suppose that the Divine Being in the beginning progressed from the simpler to the complex; from few to many; similarly that He in the beginning of the plant kingdom created as many plants as there were natural orders. These plant orders He himself, therefrom producing, mixed among themselves until from them originated those plants which today exist as genera ... Nature then mixed up these plant genera ... multiplied them into the existing species."

(d) Darwin:

"In determining whether a form should be ranked as a species or a variety, the opinion of naturalists having sound judgement and wide experience seems the only guide to follow."

(e) Mayr (1942):

"Species are groups of actually or potentially inter breeding natural populations which are reproductively isolated from other such groups." (The Biological Species Concept.)

To determine the bounds of a species according to Mayr's definition involves a vast programme of experimental hybridisation to each instance. Such programmes are being carried out on most of the major crop plants and on a very considerable number of other species as well. This approach is very attractive to the crop botanist, because he is always on the look-out for new sources of variability and he is therefore interested in the ultimate range of crossability amongst the species with which he is concerned.

The terms race, variety and subspecies are interchangeable and relate to groups within a species; these will hybridise readily. If we follow Mayr's definition of a species it follows that the species which are grouped together in a GENUS will not (normally) hybridise the one with the other. One of the interesting consequences of the application of the Biological Species Concept in crop plants is that there has been a reshuffling of several species and genera. For example the nearest wild relative of maize (Zea mais), teosinte, was generally regarded as a member of another genus, EUCHLAENA; after intensive hybridisation experiments H.G. Baker (1970) suggested that not only ZEA and EUCHLAENA, but also a third genus, TRIPSACUM, might all be included in the one genus. Similarly, Bowden (1959) has suggested lumping together the genera TRITICUM (wheat) and AEGILOPS, but not all taxonomists accept this.

The Biological Species Concept works quite neatly when we are dealing with cross-fertilised groups, but there are vast numbers of self-fertilising groups also. Local varieties of (self-fertilised) cereals in Britain are composed of a number of pure lines showing some degree of adaptation to their local environment. Now in these instances just where you draw the line between race and species is obviously a matter of opinion.

Polyploidy is another factor which poses problems for the systematist. There are many plant groups, 30-35% of the flowering plants, which include sub-groups differing in chromosome number, e.g. cocksfoots may have 14 or 28 chromosomes, cotton has 26, the diploid, or 52, the tetraploid. American cotton is a tetraploid and it is believed to be a hybrid between the two diploid cottons GOSSYPIUM raimondii, which occurs in Peru, and G.herbacium, which is African. These diploid species can be crossed, but the hybrid is sterile; however, at the tetraploid level the hybrid is fertile.

Very occasionally diploid parents give rise to tetraploid progeny; normally the latter do not inter-breed with their diploid progenitors and so, on this score, they qualify to be classed as a new species - again this is a matter of the systematist's discretion.

It would appear that John Locke's view that the "boundaries of species ... are made by men" is not altogether unfounded. It is worth noting that the total number of families of flowering plants was given by Cronquist in 1968 as 350, and by Takhtadjan in 1969 as 440!

What were the 'kinds' of Genesis 1? We do not know; we accept, by faith, that God in the beginning created 'kinds', the boundaries of which have not been transgressed. Just what those boundaries were, in scientific terms, we shall never know; a scientific delineation of the 'kinds' would in any case be incomplete. In the history of plant classification the transitory, relative and incomplete nature of scientific theories is illustrated perhaps more clearly than in most fields of enquiry.

(iii) CROP PLANTS AND WEEDS

The remarkable variability within a given species which has been referred to is of great significance in this context. This variability is characteristic of self-fertilised species as well as cross-fertilised (Stebbins, 1970)*, and it enables the cultivator to select plants well suited to his particular requirements. This is true of all growers, but more so with respect to the plant breeder. Having made his selection the grower or plant breeder wishes to ensure that the progeny of his selected plants will also exhibit the same advantageous characteristics; with a view to seed increase for his own and other growers' use he wishes to guard against the tendency for the progeny to show the same wide range of variability which confronted him before he made his initial selection. So he endeavours to restrict the genetic make-up of his selected material.

Views of three contemporary botanists on variability and its restriction in crop plants are noted:

(i) That variability in plant species is not unlimited is suggested by the title of a paper by Prof. J. Heslop Harrison, FRS, "The plant kingdom; an exhaustless resource?" He writes:

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* Stebbins' view is in sharp contrast to that propounded by Thoday in 1959 namely that self-fertilisation must eventually disappear as the result of natural selection, since cross-fertilised groups were supposedly better equipped to achieve the variability necessary to adapt to changing environments.

"The problem with cultivating plants is an agonising one, for the irony is that elevating the productivity of world agriculture by introducing modern, high-yielding varieties tends to result in the progressive disappearance of the very genetic variation upon which further advance depends. The restriction of the genetic base of production ... can be seen in the recommended variety lists of the advanced countries, where in response to special demands such as those of the food freezing industry ... fewer and fewer genotypes contribute more and more to total production, e.g. 2 varieties provide 90% of the pea crop in USA ... this not only jeopardises the breeding 'gene pool', it also carries the hazard common to all monocrop cultivation - calamitous disease."

He then quotes the "near disastrous episode of 1970 when hybrid maize seed production in the US was severely affected by Southern corn blight; this was due to the (deliberately) restricted genetic make-up of the varieties in question.

(ii) Harlan (1970) suggests that the development of local races, in the absence of the sophisticated approach of the plant breeder, is somewhat as follows: Farmers tend to stay at the same farm for many years; they sow their wheat and barley every year, and at harvest time some seed is kept for the next year's sowing. In this way local varieties emerge, each one adapted to particular local conditions. Occasionally the farmer moves away, taking his seed stocks with him. There is then opportunity for (limited) crossing to occur between the transported varieties and the local types. Such cycles of differentiation and hybridisation are regarded as the means of maintaining variability in crop plants, and many detailed studies of this phenomenon have been undertaken. For example, it is recognised that there is great diversity in popcorns in Turkey, and it appears that this irruption of variability can be traced to the introduction of two races into Turkey by different routes.

(iii) Sir Joseph Hutchinson (Crop Plant Evolution, 1965) suggests that in all crop plants cross-pollination must have occurred in some ancestors; this he deduced from the flower structure. In order to preserve particular characteristics man has made use of tendencies to self-fertilisation. There are, in fact, several instances when the highest yields, and other desirable features, are obtained in sterile, or near sterile, plants, e.g. bananas, watermelons, sugar-beet. In these varieties vegetative propagation or special methods of reproductive increase are necessary.

The crop botanist recognises that within a species three categories may be distinguished (Harlan, 1970):

(a) cultivated: forms habitually established by man with the purpose and expectation of a later harvest,

(b) weed: a race adapted to habitats disturbed by man's activities,

(c) wild: a race neither cultivated nor markedly encouraged by human disturbance.

The relationship between crop and weed races of the same species is of very great importance to the crop botanist. There are weed races of most important crop species, including wheat, rice, maize, potato, tomato ... One of the crops most thoroughly investigated in this respect is sorghum. It has been found that when a new sorghum variety is introduced into an area, there is generally a certain amount of crossing with the native weed sorghums and as a result there is increased genetic variability both in the crop, (i.e. the introduced variety) and in the weed race.

Weed infestation is a serious and exasperating problem, especially when crop and weed belong to the same species; hybridisation and selection then tends to increase their resemblence the one to the other and hence renders separation at harvest the more difficult.

Variability in plants contributes wonderfully to the adaptability of the various species for different forms of cultivation; it also contributes to the continuing presence of weeds. 'Thorns and thistles' (plants taking the place of, and thus diminishing the yield of those being cultivated or grazed?) were not formed once for all; rather the mechanism of heredity is such that weeds and diseases continue to arise. Thus whilst we recognise that variability may be subsumed under the 'good' of Gen. 1:12, we recognise that it contributes also to the 'thorns and thistles' of Gen. 3:18. Furthermore, sterility, which one would perhaps be inclined to regard as a wholly detrimental characteristic, is an attribute of some of the best food plants; but it may bring in its train a heightened vulnerability to new disease organisms. In other words it does not seem to be possible to distinguish the original 'good' creation from the subsequently 'cursed' earth in scientific terms.

When crop botanists, concurring with Harlan (1970), categorise plants as 'cultivated' and 'weed' races, they are following (by common grace?) the biblical division 'good for food' Gen. 2:2, and 'thorns and thistles' Gen. 3:18. Onto this classification, however, Harlan seeks to superimpose an evolutionary outlook which is both fruitless and baffling. He writes (with reference to rice) "both crop and weed are smashing evolutionary successes"!

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REVIEWS

The *Science and Creation* series.

We have received the following series of books from the Mayflower Christian Bookshop, 2 Jameson Rd, Southampton SO2 7HY. This bookshop offers them at the prices given below, and also offers the full set of eighteen books for 17.00.

SCIENCE AND CREATION, by W.W. Boardman, Jr, R.F. Koontz, and H.M. Morris, Creation-Science Research Center, San Diego, California, 1973. Pb, 207pp. 1.25.

Here is value for money; a compact, well-written introduction to the scientific aspects of the creation-evolution debate. Produced by an American team of authors, this slim volume is nevertheless free from transatlantic stylistic excesses. Rather, this low-key, soberly produced book is well suited to the reserved British reader! Part I commences with two introductory chapters. The first covers alternative approaches to Origins and creationism as a scientific theory. The second chapter presents a helpful overview of the way in which the issues of creation and origins impinge upon the Physical, Earth, Life and Social Sciences.

Part II picks up the classical arguments for organic evolution and subjects them to re-evaluation. There then follow chapters on the Origin of Life (chemical evolution) and on the Age of the Universe, the Solar System and the Earth. The final chapter contains a good account of the major cosmological theories and of the criticisms which have been levelled against them by proponents of alternative hypotheses.

This book pre-supposes some familiarity with scientific concepts, but it is pitched at a level which should make it helpful to many. Certainly those who have successfully pursued scientific studies beyond (or merely up to) GCE 'O' level should benefit from this introduction. Although the material is compressed, the pitfalls of over-generalisation and of disconnected facts are reasonably well avoided. Ample documentation is provided to the general scholarly literature, which is a great asset.

Here and there one might criticise for a tendency to try and prove too much, too fast. For example, on p 151 there is a discussion of the depth of lunar soil and the fact that (A) this is less than that expected on the basis of (i) an assumed evolutionary age and (ii) the present rate of meteoritic dust fall-out *on earth*. However, an additional fact (B) is forthcoming: there is recent evidence that the rate of micrometeorite impact is lower on the moon than on the earth. It ought to be recognised that B somewhat reduces the argument against an evolutionary age for the moon on the basis of A. The authors fail to point this out. (This criticism is not intended to overthrow the argument from A, but to qualify it in the light of *all* the evidence.)

In summary, this book is a generally reliable guide to its subject with remarkably few blemishes. It is strongly recommended.

David C. Watts

SCIENCE AND CREATION: A SCRIPTURE SUPPLEMENT, by K.L. Segraves and R.E. Kofahl, 1973, Pb, 118pp. 1.00.
SCIENCE AND CREATION SERIES, volumes 1-8: THIS WONDERFUL WORLD, OUR CHANGING WORLD, THE WORLD OF LONG AGO, THE LIVING WORLD, MAN AND HIS WORLD, WORLDS WITHOUT END, BEGINNING OF THE WORLD and THE WORLD AND TIME; teachers' books, 11x8½", approx. 32pp, 90p each; students' books, 10x7¾", 32pp, 85p each. Magazine format. Edited by H.M. Morris and J.F. Phelps.

The intention of this series is that it should be used in a school or some other context (Sunday School, perhaps, or the home) as a basis for primary science education. The eight course books (each in two versions - one for the pupil, one for the teacher) roughly span the pre-secondary years, moving from simple 'nature study' seeking design and purpose in creation to discussions of vulcanism and radioactivity. The pupil's book, with 32 large format pages, is the basis of each stage of the course. The teacher's book, of around the same length though with slightly larger pages, gives teaching notes with background information and plenty of ideas for activities, experiments, project-work, and the like. References are made to the science textbook reviewed above where more technical discussions may be found. The pages of the pupil's nook are reproduced in miniature in the teacher's, surrounded by notes.

The Scripture Supplement sets out to provide Biblical background information to the scientific material in the teaching books. 'Full Scripture quotations are given which reinforce the scientific concepts with the Biblical support.' This volume also contains page-references to the teaching books, and devotes one chapter to each of the eight. Within a brief running commentary on the flow of the argument in the teaching course, a catena of texts is drawn up (and usually given in full) throwing some light on the matter under consideration. Sometimes this is more illuminating than others. Biblical teaching on creation, for example, stands in a different relation to scientific enquiry than Biblical allusions to particular animals (compare pp 8-14 with 15-18). It is perhaps inevitable that with this 'proof-text' type of method there will be sometimes a lack of sensitivity in dealing with the Scriptures involved. For instance, John 8:32 ('And ye shall know the truth, and the truth shall make you free') is found under 'Scriptural support' for a young-earth interpretation of the dating 'clocks'. A more sophisticated Biblical-theological discussion along the lines of the scientific book discussed above and in similar detail might have proved a more helpful companion volume on the Biblical side.

The value of the series might best be illustrated by taking one of the pupil's books and examining it and its parallel material. Number 3 of the series, The World of Long Ago, is subtitled 'The testimony of the fossils'. Like all the children's books it is colourfully illustrated. It deals with the prehistoric world, approaching it by means of children's knowledge of more recent history. There is a discussion of fossils, and the example is given of a mouse caught in a flood, illustrated in colour. (Is this, I asked myself, a suitable example for a child of perhaps seven or eight years old?) We then move to the communities of which fossilised animals were a part, their food-chains, and the rock-strata in which they are found. Finally, there are several pages on the ever-popular dinosaurs.

The teacher's book gives as the objective of this stage of the course to teach that 'interdependence and interaction with the environment are universal relationships', and provides helpful notes and references, including detailed instructions on constructing an 18"-square volcano out of plaster of Paris which will actually erupt! The Scripture Supplement adds to this a 'Scriptural Objective' which relates to it: 'to demonstrate to the pupil the reality of the Biblical teaching of the Flood and its effects upon the world in which we live'. It is not entirely clear how, in practice, these two objectives are intended to inter-relate. In using the Scriptural material, this reviewer concludes, the teacher has a great deal of thinking to do.

No doubt only by having taught from this series of books could one come to a full assessment of their usefulness. But, on examination, they have much to commend them. The series attempts an integrated study of subjects which are integrated in reality. It seeks to be faithful to Scripture and to use Scripture, though this is no easy matter. Although in Britain there could be few schoolteachers able to employ the series as a whole, for those who can make use of it, and especially for that growing minority of parents seeking to supplement their children's education or to educate them at home, these are most valuable resources.

N. M. de S. Cameron

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President Prof. Edgar Andrews, University of London
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The Revd Geoffrey Thomas, Aberystwyth

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Revd N.M.de S. Cameron

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